Objective Mapping of SWellEx-96 CTD Data

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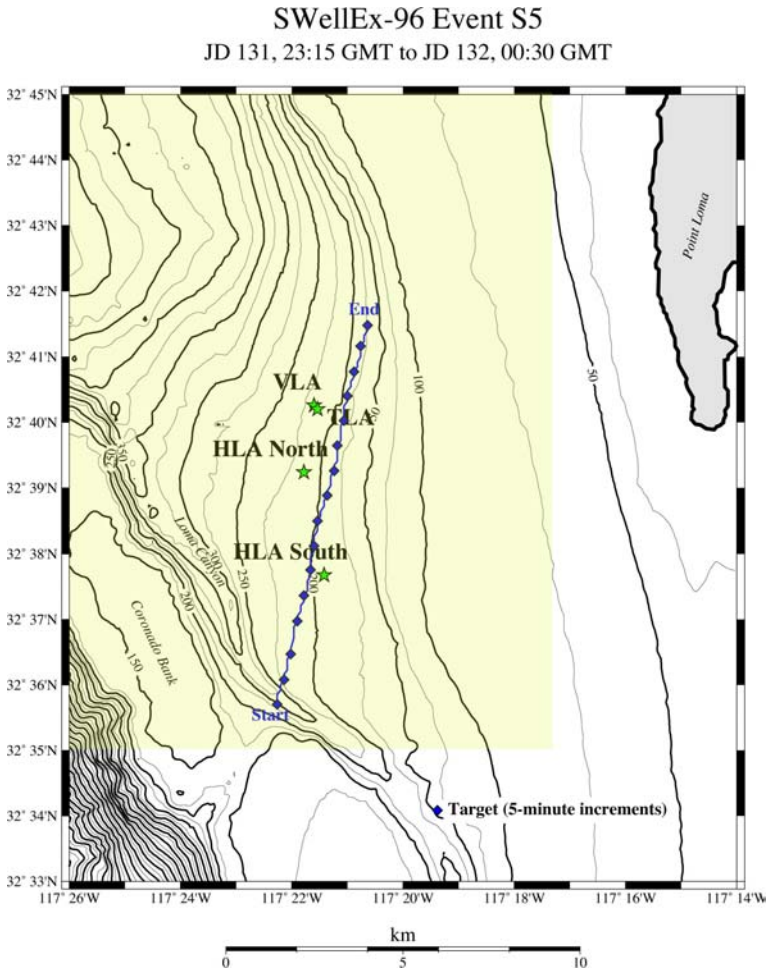
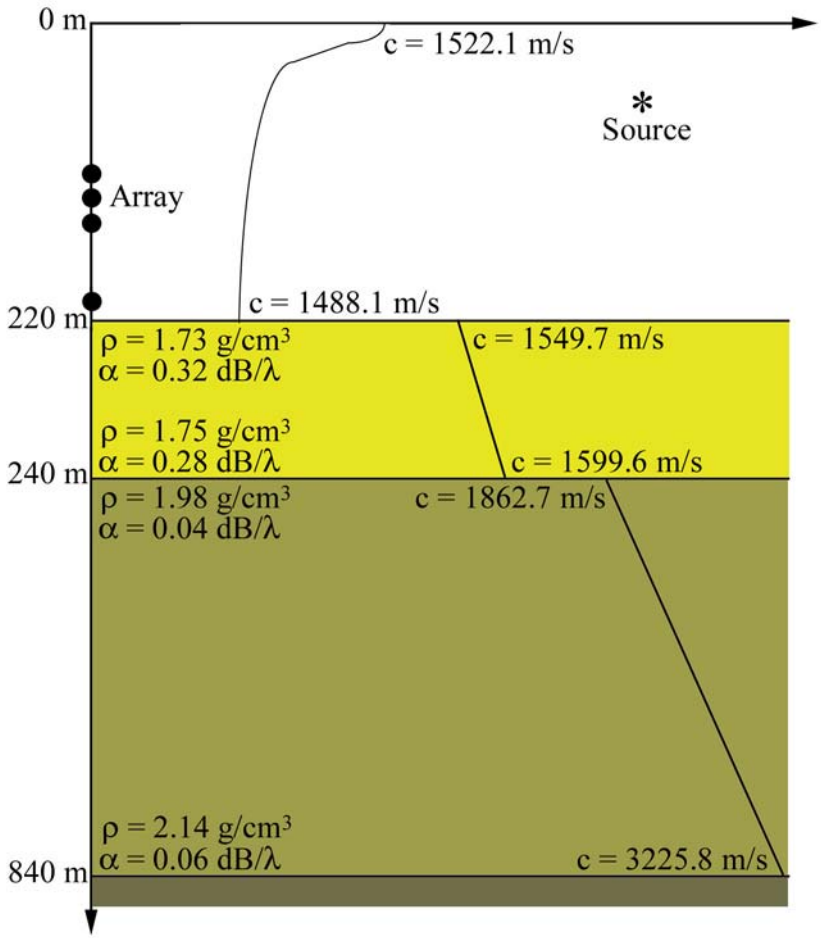
Objective & Outline

To estimate sound speed fields from a sparse dataset with the goal of utilizing the results in modeling acoustic variability

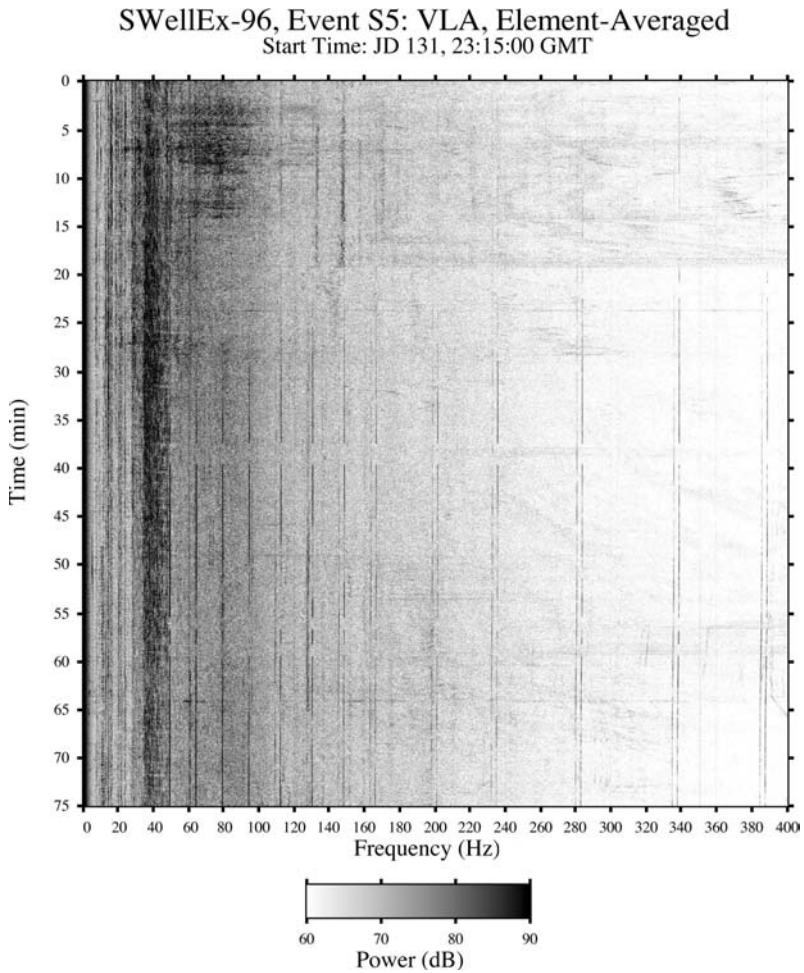
- The SWellEx-96 Experiment
- Objective Mapping
- Sound Speed Estimates
- Transmission Loss

The SWellEx-96 Experiment



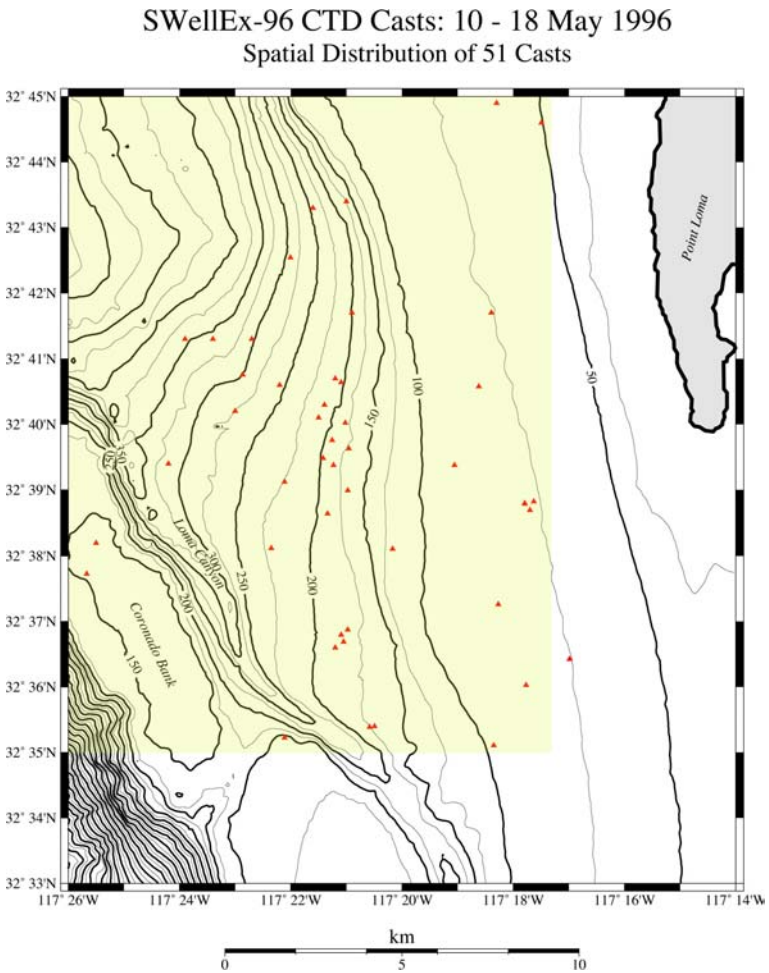


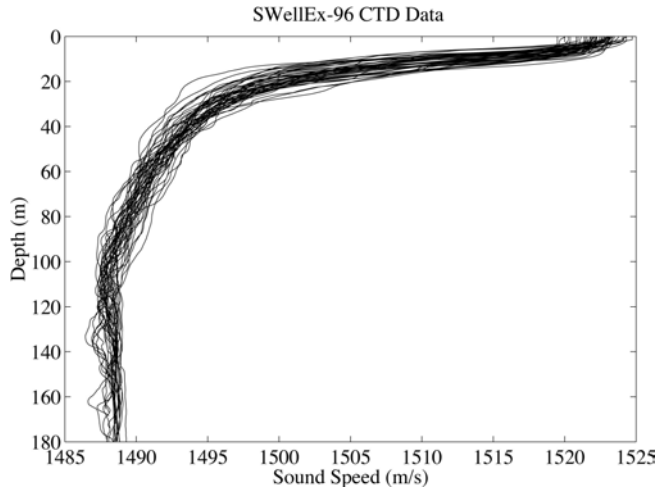
Acoustic Sources

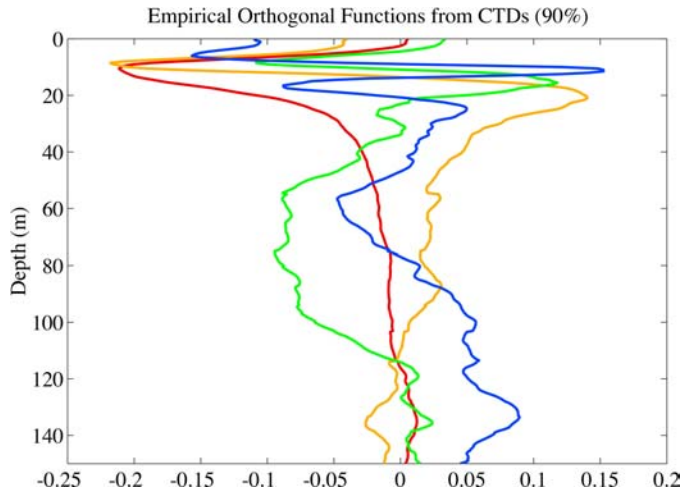


- Deep source (54 m)
  - 5 sets of 13 CW tones
  - 49 Hz – 400 Hz
  - FM chirps
- Shallow source (9 m)
  - 9 CW tones
  - 109 Hz – 385 Hz
- Devoid of loud interferers

CTD Measurements







Objective Mapping

- sparse dataset $\Rightarrow$ regularly gridded fields
- estimate $\tilde{x}$ which deviates as little as possible in the mean square from the true solution x :

$$P = \left\langle (\tilde{x} - x)(\tilde{x} - x)^T \right\rangle$$

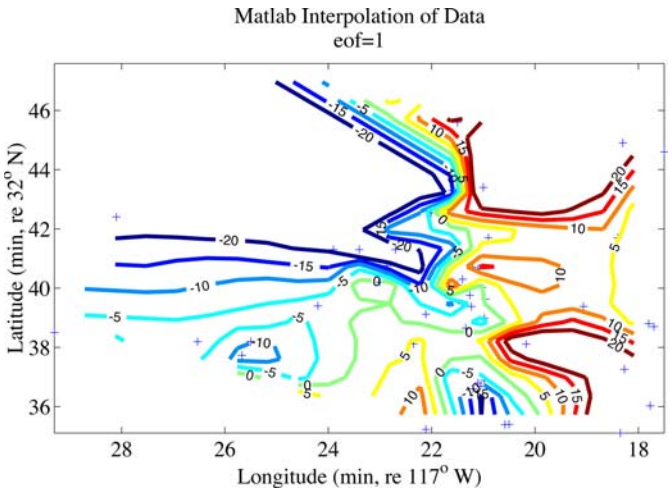
The minimum variance estimate is:

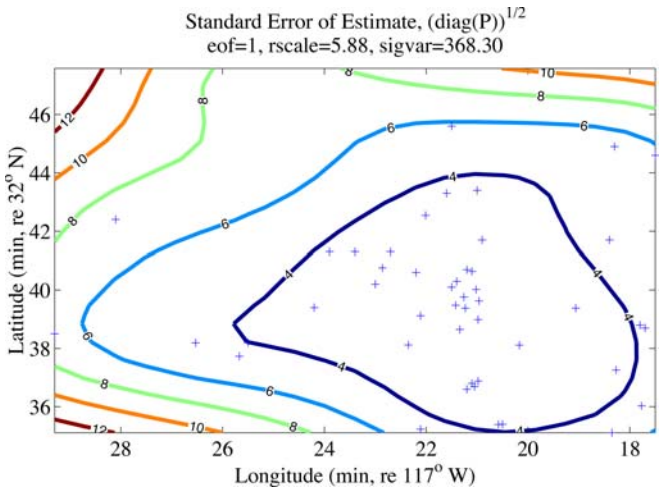
$$\tilde{x} = R_{xy} R_{yy}^{-1} y \quad \text{where} \quad y = Ex + n$$

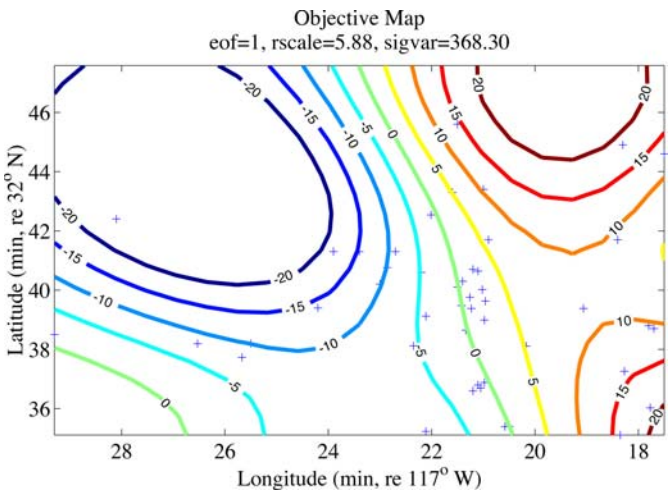
The error covariance is:

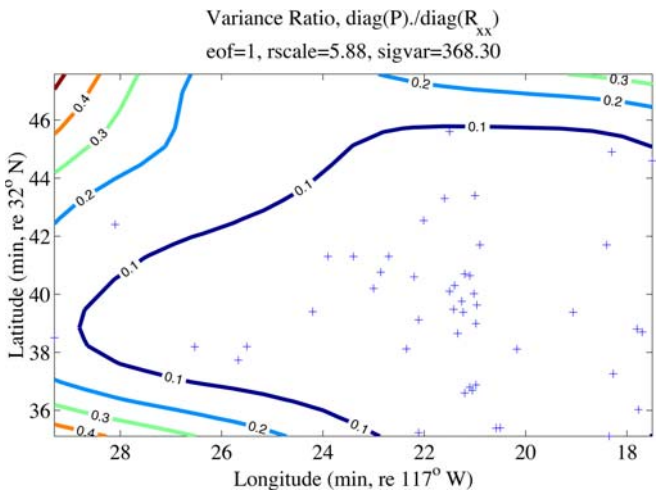
$$P = R_{xx} - R_{xy} R_{yy}^{-1} R_{xy}^T$$

Objective Mapping Results

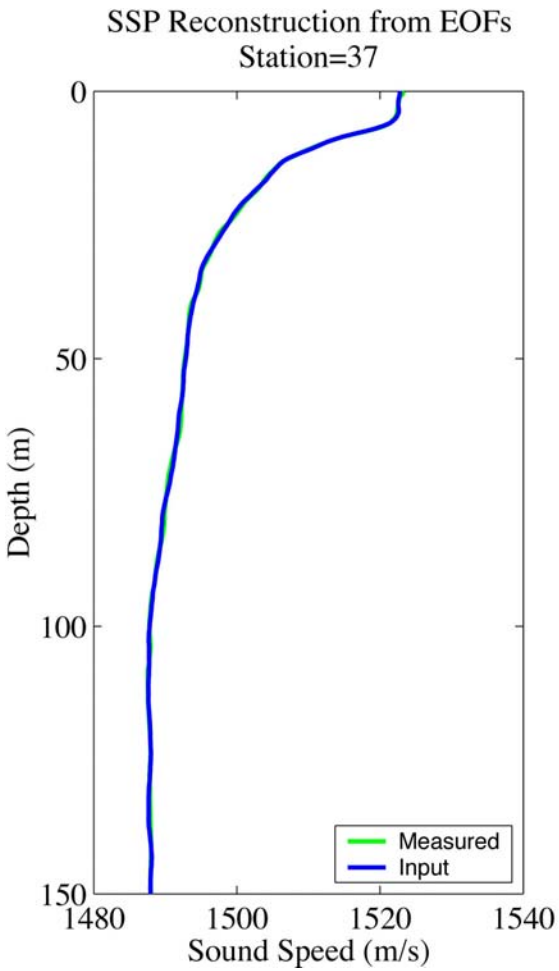


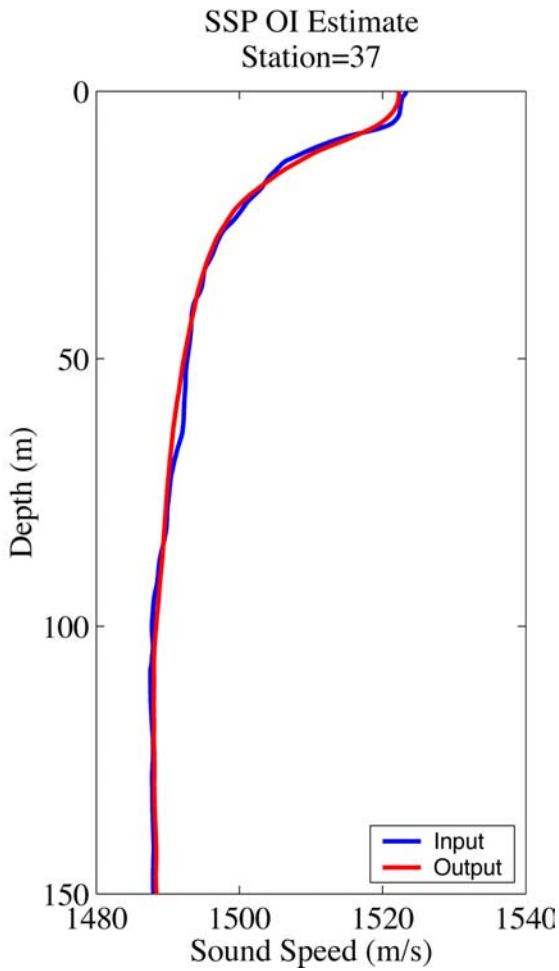




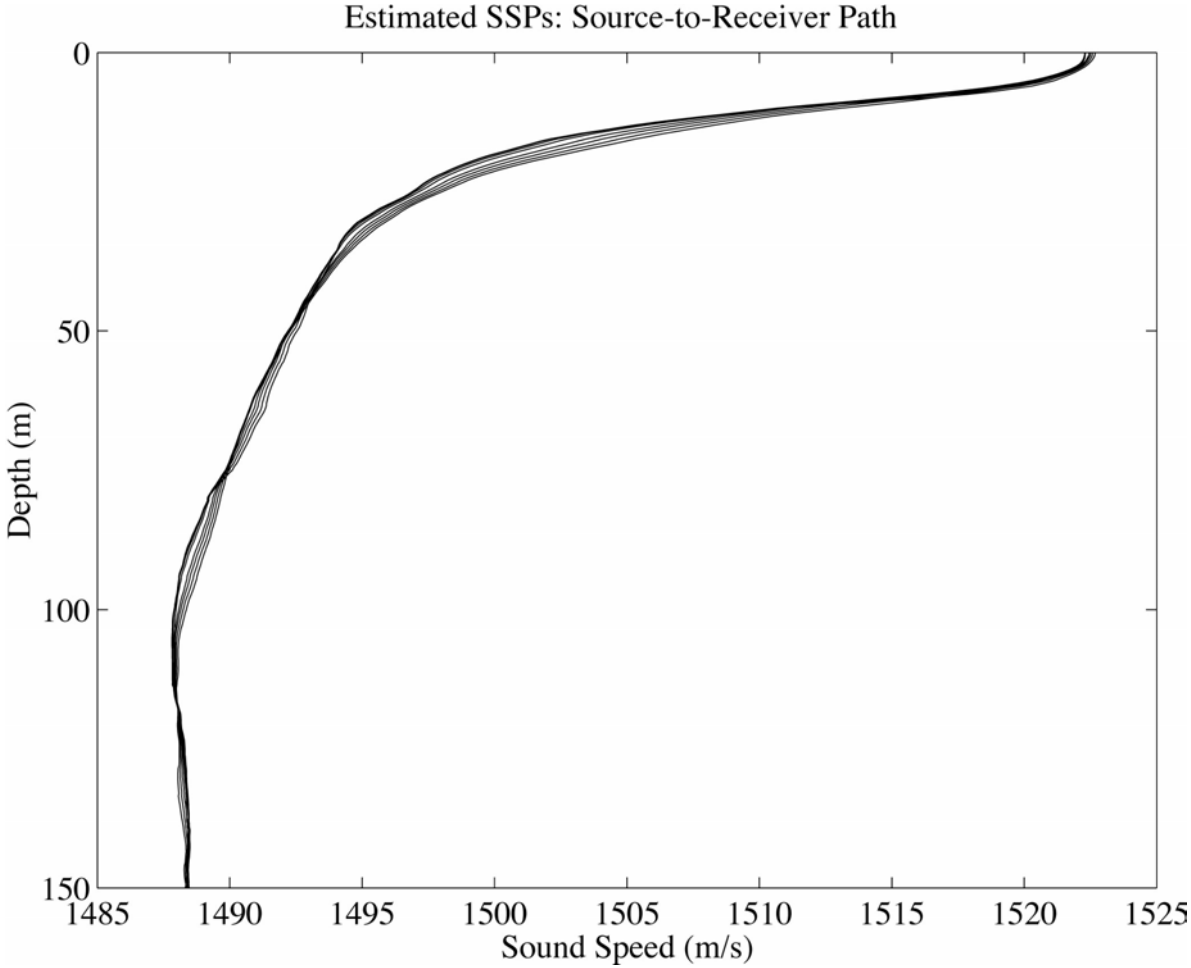


SSP Estimates

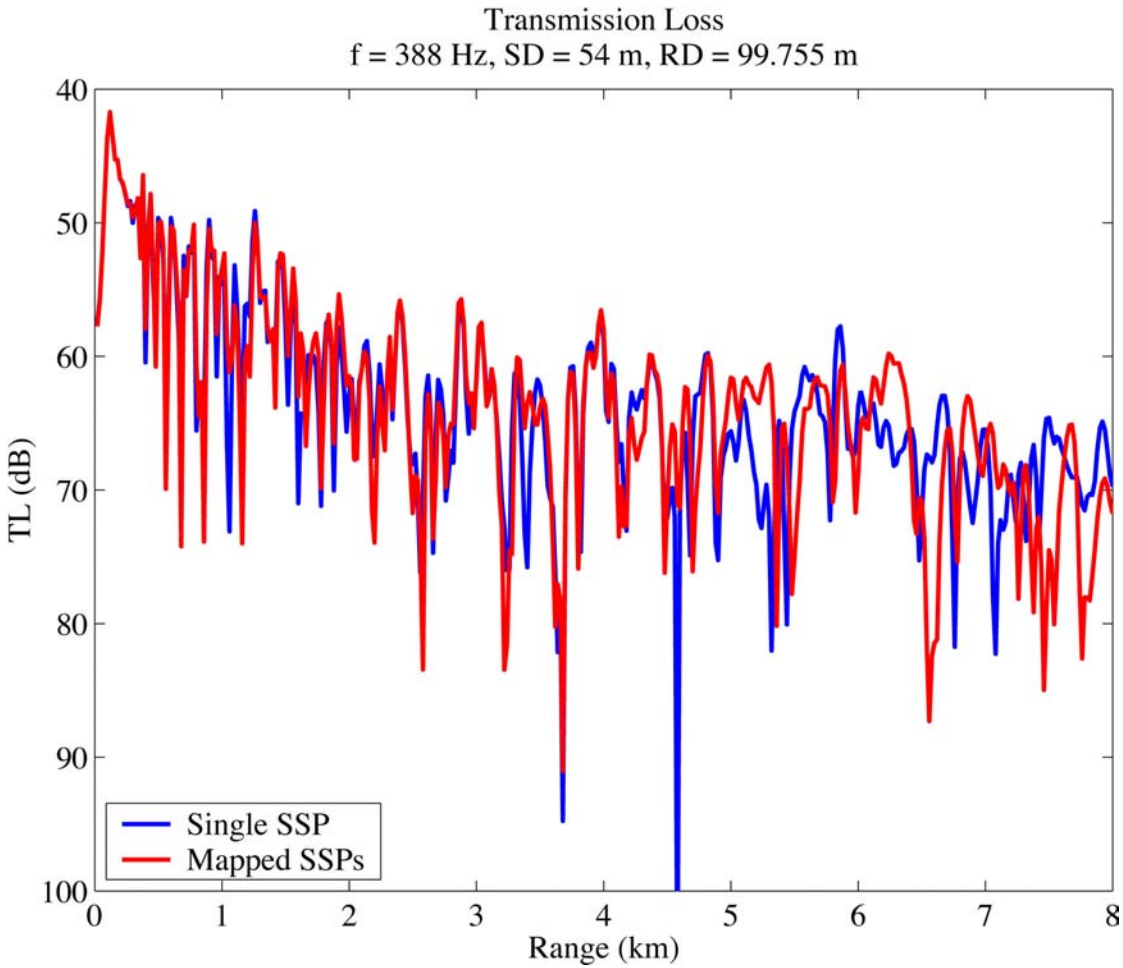




Source-to-Receiver Path



Transmission Loss



Summary

- Experimental case study
  - Compiled experimental ocean acoustic data set (SWellEx-96) for team members
- Objective mapping
  - Generated water column sound speed estimates
  - Estimates and errors consistent with expectations
  - To be used in conjunction with the ROMS model
- Preliminary acoustic field calculation
  - Small variability in sound speed can affect ocean acoustic propagation
  - At low frequencies, the local effects are small but the cumulative effect on acoustic propagation could be significant over long ranges